Cisco 1710 Security Router Software Configuration Guide

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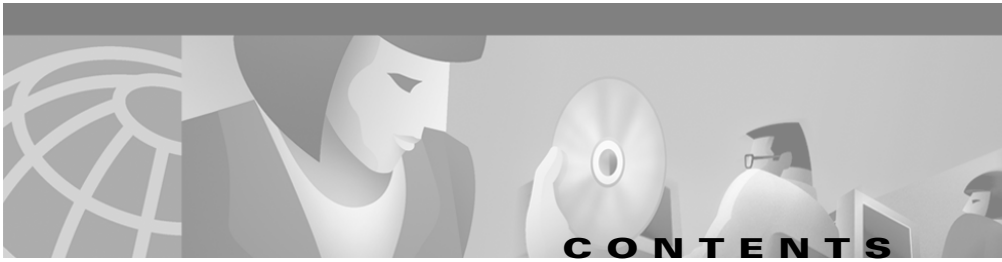

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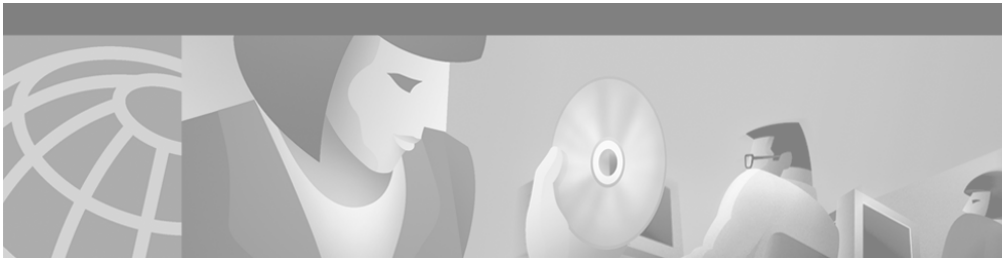

Preface

This preface describes the objectives, audience, organization, and conventions of the *Cisco 1710 Security Router Software Configuration Guide.* It also provides information about additional documentation and how to obtain technical assistance.

Objectives

This software configuration guide explains how to configure the Cisco 1710 router. It does not cover every feature, but does describe, in detail, the tasks most commonly required to configure the router.

This guide also references detailed features described in the Cisco IOS configuration guides and command references. Refer to these other books for additional information.

Audience

This guide is intended primarily for the following audiences:

- Enterprise companies with remote or small branch offices connecting to corporate site and branch offices (site-to-site connection), or between branch offices through secure Virtual Private Network (VPN) tunnels.
- Small and medium size businesses needing to provide mobile users with secure VPN access to network resources at the central site; or connect to partner locations through a secure tunnel.

- Service providers offering VPN services to enterprise and small-to-medium sized businesses. Service providers can bundle Cisco VPN hardware with their service offerings.
- Providers of Internet connections to the whole multi-tenant office building.

Organization

This document contains the following chapters and appendix:

- Chapter 1, "Introduction to Router Configuration"—Describes briefly the configuration of a router through Cisco IOS.
- Chapter 2, "Cisco 1710 Security Router Configuration"—Describes what you need to know about the Cisco IOS software (the software that runs the router) before you begin to configure the router.
- Chapter 3, "Overview of Routing Between Virtual LANs"—Provides an overview of virtual LANs (VLANs).
- Chapter 4, "Configuring Routing Between VLANs with IEEE 802.1Q Encapsulation"—Describes the required and optional tasks for configuring routing between VLANs with IEEE 802.1Q encapsulation.
- Appendix A, "ROM Monitor"—Describes the functions and commands of the router ROM monitor (also called the bootstrap program), the firmware that runs when the router is powered up or reset.

Conventions

This document uses the following conventions:

- The caret character (^) represents the Control key.

  For example, the key combinations ^D and Ctrl-D are equivalent: Both mean hold down the Control key while you press the D key. Keys are indicated in capitals, but are not case sensitive.

Command descriptions use these conventions:

- Commands and keywords in **boldface** font.
- Variables for which you supply values are in *italic* font.

Examples use these conventions:

- Examples that contain system prompts denote interactive sessions, indicating that you enter commands at the prompt. The system prompt indicates the current command mode. For example, the following prompt indicates global configuration mode:

  ```
  Router(config)#
  ```

- Terminal sessions and information the system displays are in `screen` font.
- Information you enter is in **`boldface screen`** font.
- Nonprinting characters, such as passwords, are in angle brackets (< >).

Note Means *reader take note*. Notes contain helpful suggestions or references to materials not contained in this manual.

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Timesaver Means the *described action saves time*. You can save time by performing the action described in the paragraph.

Related Documentation

The following publications provide related information on this product:

- *Cisco IOS Software Configuration: Cisco IOS Release 12.2: Configuration Guides and Command References* provide complete information about all the Cisco IOS CLI commands and how to use them, as well as information on designing and configuring LANs and WANs.
- *Quick Start Guide for Installing Your Cisco 1710 Security Router* has instructions for quickly cabling and powering up the router.

- *Cisco 1710 Security Router Hardware Installation Guide* describes router features, how to install and cable the router, and how to troubleshoot common problems you may have with it.

Obtaining Documentation

The following sections provide sources for obtaining documentation from Cisco Systems.

World Wide Web

You can access the most current Cisco documentation on the World Wide Web at the following sites:

- http://www.cisco.com
- http://www-china.cisco.com
- http://www-europe.cisco.com

Documentation CD-ROM

Cisco documentation and additional literature are available in a CD-ROM package, which ships with your product. The Documentation CD-ROM is updated monthly and may be more current than printed documentation. The CD-ROM package is available as a single unit or as an annual subscription.

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- Registered Cisco Direct Customers can order Cisco Product documentation from the Networking Products MarketPlace:

  http://www.cisco.com/cgi-bin/order/order_root.pl

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Obtaining Technical Assistance

Cisco provides Cisco.com as a starting point for all technical assistance. Customers and partners can obtain documentation, troubleshooting tips, and sample configurations from online tools. For Cisco.com registered users, additional troubleshooting tools are available from the TAC website.

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To access Cisco.com, go to the following website:

http://www.cisco.com

Technical Assistance Center

The Cisco TAC website is available to all customers who need technical assistance with a Cisco product or technology that is under warranty or covered by a maintenance contract.

Contacting TAC by Using the Cisco TAC Website

If you have a priority level 3 (P3) or priority level 4 (P4) problem, contact TAC by going to the TAC website:

http://www.cisco.com/tac

P3 and P4 level problems are defined as follows:

- P3—Your network performance is degraded. Network functionality is noticeably impaired, but most business operations continue.
- P4—You need information or assistance on Cisco product capabilities, product installation, or basic product configuration.

In each of the above cases, use the Cisco TAC website to quickly find answers to your questions.

To register for Cisco.com, go to the following website:

http://www.cisco.com/register/

If you cannot resolve your technical issue by using the TAC online resources, Cisco.com registered users can open a case online by using the TAC Case Open tool at the following website:

http://www.cisco.com/tac/caseopen

Contacting TAC by Telephone

If you have a priority level 1 (P1) or priority level 2 (P2) problem, contact TAC by telephone and immediately open a case. To obtain a directory of toll-free numbers for your country, go to the following website:

http://www.cisco.com/warp/public/687/Directory/DirTAC.shtml

P1 and P2 level problems are defined as follows:

- P1—Your production network is down, causing a critical impact to business operations if service is not restored quickly. No workaround is available.
- P2—Your production network is severely degraded, affecting significant aspects of your business operations. No workaround is available.

Introduction to Router Configuration

If you understand Cisco IOS software (the software that runs your router) and you are experienced in configuring network devices, you can use the Cisco IOS command-line interface (CLI) to configure your router. The purpose of this guide is to help you use Cisco IOS software to configure your Cisco 1710 Security router. This chapter describes what you need to know before you begin configuring your router with Cisco IOS software.

This chapter contains the following sections:

- Configuring the Router from a PC
- Understanding Command Modes
- Getting Help
- Enable Secret and Enable Passwords
- Entering Configuration Mode
- Using Commands
- Saving Configuration Changes
- Using Debug Commands
- Where to Go Next

Understanding these concepts saves you time when you are configuring your router. If you have never used the Cisco IOS software or need a refresher, take a few minutes to read this chapter before you proceed to the next chapter.

If you are already familiar with the Cisco IOS software, you can proceed to the configuration chapter that is appropriate for your network.

Configuring the Router from a PC

If you are configuring your router from a PC (not a dumb terminal), you need a type of communications software called *terminal emulation* software. The PC uses this software to send commands to your router. Table 1-1 lists some common names for this software, based on the type of PC you are using.

Table 1-1 Terminal Emulation Software

PC Operating System	Software
Windows 95, Windows NT	HyperTerminal (included with Windows software)
Windows 3.1	Terminal (included with Windows software)
Macintosh	ProComm, VersaTerm (supplied separately)

You can use the terminal emulation to change settings for the type of device that is connected to the PC, in this case a router. Configure the software to the following settings, so that your PC can communicate with your router:

- 9600 baud
- 8 data bits
- No parity
- 1 stop bit
- No flow control

You can now configure your router using your PC.

Understanding Command Modes

This section describes the Cisco IOS command mode structure. Each command mode supports specific Cisco IOS commands. For example, the **interface** *type_number* command is used only when in global configuration mode.

You use the following Cisco IOS command modes when configuring the scenarios described in this document:

- User EXEC
- Privileged EXEC
- Global configuration
- Interface configuration
- Router configuration
- Line configuration

Note Throughout the examples in this guide, there are steps for verifying your router configuration by using different Cisco IOS commands. If you plan to use these verification steps, you must understand how to change from one command mode to another, as summarized in Table 1-2.

Table 1-2 lists the command modes that are used in this guide, how to access each mode, the prompt you see in that mode, and how to exit that mode. The examples in the table use the host name *1710*.

Table 1-2 Command Modes Summary

Mode	Access Method	Prompt	Exit Method	About This Mode[1]
User EXEC	Begin a session with your router.	`1710>`	Enter the **logout** command.	A subset of the commands available in this mode. Use this mode to • Change terminal settings. • Perform basic tests. • Display system information.
Privileged EXEC	Enter the **enable** command while in user EXEC mode.	`1710#`	• To exit to user EXEC mode, enter the **disable** command. • To enter global configuration mode, enter the **configure** command.	Use this mode to • Configure your router operating parameters. • Perform the verification steps shown in this guide. You should configure your router with an enable password to prevent anyone from making unauthorized changes to the router configuration.

Table 1-2 Command Modes Summary (continued)

Mode	Access Method	Prompt	Exit Method	About This Mode[1]
Global configuration	Enter the **configure** command while in privileged EXEC mode.	`1710(config)#`	• To exit to privileged EXEC mode, enter the **exit** or **end** command, or press **Ctrl-Z**. • To enter interface configuration mode, enter the **interface** command.	Use this mode to configure parameters that apply to your router as a whole.
Interface configuration	Enter the **interface** command (with a specific interface) while in the global configuration mode.	`1710(config-if)#`	• To exit to global configuration mode, enter the **end** command. • To exit to privileged EXEC mode, enter the **exit** command, or press **Ctrl-Z**. • To enter subinterface configuration mode, specify a subinterface with the **interface** command.	Use this mode to configure parameters for the various LAN interfaces of your router, including the • 10BaseT Ethernet interface. • 10/100BaseT FastEthernet interface.

Table 1-2 Command Modes Summary (continued)

Mode	Access Method	Prompt	Exit Method	About This Mode[1]
Router configuration	Enter your router command followed by the appropriate keyword while in global configuration mode.	`1710(config-router)#`	• To exit to global configuration mode, enter the **end** command. • To exit to privileged EXEC mode, enter the **exit** command, or press **Ctrl-Z**.	Use this mode to configure an IP routing protocol.
Line configuration	Specify a line with the **line vty** command while in the global configuration mode.	`1710(config-line)#`	• To exit to global configuration mode, enter the **exit** command. • To enter privileged EXEC mode, enter the **end** command, or press **Ctrl-Z**.	Use this mode to configure parameters for the terminal line.

1. For any of the modes, you can see a comprehensive list of the available commands by entering a question mark (?) at the prompt.

Getting Help

You can use the question mark (?) and arrow keys to help you enter commands. Here are some ways to get help while in any command mode:

- Enter a question mark to list the commands that are available in the current mode. You can restrict the list to all commands starting with a specific letter by entering that letter, followed by a question mark (no space):

```
Router (config-if)# s?
  shutdown
  snapshot
  snmp
  standby
```

- Enter a command, a space, and a question mark to list the available keywords (and a short definition of the keywords) that can be used with the command:

```
Router (config-if)# snapshot ?
  client Enable client control of Snapshot routing
  server Send routing updates out this link when updates are
received
```

- Enter a command, a keyword, a space, and a question mark to list the range of values (and a short definition of the values) that you can enter with the command:

```
Router (config-if)# snapshot client ?
  <5-1000> duration, in minutes, of each active period
```

- Enter a few known characters to have the router complete the command. In this example, the command is **show hosts**:

```
Router> sh ho
Default domain is not set
Name/address lookup uses domain service
Name servers are 255.255.255.25
```

- To redisplay a command you previously entered, press the up arrow key. You can continue to press the up arrow key for more commands. The commands are displayed in the reverse order from which they were entered.

Enable Secret and Enable Passwords

Because many privileged EXEC commands are used to set operating parameters, you should password-protect these commands to prevent unauthorized use.

You use two commands to do this:

- **enable secret** *password* (a very secure, encrypted password)
- **enable** *password* (a less secure, unencrypted password)

You must enter an enable secret password to gain access to privileged EXEC mode commands.

For maximum security, the passwords should be different. If you enter the same password for both during the setup process, your router accepts the passwords, but warns you that they should be different.

An enable secret password can contain from 1 to 25 uppercase and lowercase alphanumeric characters. An enable password can contain any number of uppercase and lowercase alphanumeric characters. In both cases, a number cannot be the first character. Spaces are also valid password characters; for example, "two words" is a valid password. Leading spaces are ignored; trailing spaces are recognized.

If you lose or forget your enable password, refer to the "Troubleshooting" appendix in the *Cisco 1710 Security Router Hardware Installation Guide* that came with your router.

Entering Configuration Mode

To make any configuration changes to your router, you must be in configuration mode. This section describes how to enter configuration mode while using a terminal or PC that is connected to your router CONSOLE port.

To enter configuration mode:

Step 1 After your router boots up, answer no when the following question displays:

```
Would you like to enter the initial configuration dialog [yes]: no
```

Step 2 If you have configured your router with an enable password, enter the **enable** command, and enter the enable password when you are prompted for it.

The enable password does not show on the screen when you enter it. This example shows how to enter configuration mode on a Cisco 1710 Security router:

```
1710> enable
Password: <enable_password>
Router#
```

Enable mode is indicated by the pound sign (#) in the prompt. You can now make changes to your router configuration.

Step 3 Enter the **configure terminal** command to enter configuration mode, indicated by (config)# in the prompt:

```
Router# configure terminal
Router (config)#
```

You can now make changes to your router configuration.

Using Commands

This section provides some tips about entering Cisco IOS commands at the command-line interface (CLI).

Abbreviating Commands

You only have to enter enough characters for the router to recognize the command as unique. This example show how to enter the **show configuration** command:

```
1710# show conf
Using 385 out of 7506 bytes
!
version 12.2
no service udp-small-servers
no service tcp-small-servers
.
.
.
```

Command-Line Error Messages

Table 1-3 lists some error messages that you might encounter while using the CLI to configure your router.

Table 1-3 Common CLI Error Messages

Error Message	Meaning	How to Get Help
`% Ambiguous command: "show con"`	You did not enter enough characters for your router to recognize the command.	Reenter the command followed by a question mark (?) with no space between the command and the question mark. The possible keywords that you can enter with the command are displayed.

Table 1-3 Common CLI Error Messages (continued)

Error Message	Meaning	How to Get Help
`% Incomplete command.`	You did not enter all of the keywords or values required by this command.	Reenter the command followed by a question mark (?) with no space between the command and the question mark. The possible keywords that you can enter with the command are displayed.
`% Invalid input detected at '^' marker.`	You entered the command incorrectly. The error occurred where the caret mark (^) appears.	Enter a question mark (?). All of the commands that are available in this command mode are displayed.

Undoing Commands

If you want to disable a feature or undo a command you entered, you can enter the keyword **no** before most commands; for example, **no ip routing**.

Saving Configuration Changes

You need to enter the **copy running-config startup-config** command to save your configuration changes to nonvolatile random-access memory (NVRAM) so that they are not lost if there is a system reload or power outage. This example shows how use this command to save your changes:

```
Router# copy running-config startup-config
Building configuration...
```

It might take a minute or two to save the configuration to NVRAM. After the configuration has been saved, the following appears:

```
[OK]
Router#
```

Using Debug Commands

Debug command are provided for most of the configurations in this document. You can use the debug commands to troubleshoot any configuration problems that you might be having on your network. Debug commands provide extensive, informative displays to help you interpret any possible problems.

Table 1-4 contains important information about debug commands.

Caution Debugging is assigned a high priority in your router CPU process, and it can render your router unusable. For this reason, use debug commands only to troubleshoot specific problems.The best time to use debug commands is during periods of low network traffic and few users to decrease the likelihood that the debug command processing overhead affects network users.

Table 1-4 Important Information About Debug Commands

What	Information
Additional documentation	You can find additional information and documentation about the debug commands in the *Debug Command Reference* document on the Cisco IOS software documentation CD-ROM that came with your router. If you are not sure where to find this document on the CD-ROM, use the Search function in the Verity Mosaic browser that comes with the CD-ROM.
Disabling debugging	To turn off any debugging, enter the **undebug all** command.
Telnet sessions	If you want to use debug commands during a Telnet session with your router, you must first enter the **terminal monitor** command.

Where to Go Next

Now that you have learned some Cisco IOS software basics, you can begin to configure your router.

Remember that

- You can use the question mark (?) and arrow keys to help you enter commands.
- Each command mode restricts you to a set of commands. If you are having difficulty entering a command, check the prompt, and then enter the question mark (**?**) for a list of available commands. You might be in the wrong command mode or using the wrong syntax.
- If you want to disable a feature, enter the keyword **no** before the command; for example, **no ip routing**.
- You need to save your configuration changes to NVRAM so that they are not lost if there is a system reload or power outage.

CHAPTER 2

Cisco 1710 Security Router Configuration

This chapter presents basic configuration procedures for features of the Cisco 1710 Security router. For a full description of these features and their configurations, please refer to *Cisco IOS Software Configuration: Cisco IOS Release 12.2*.

This chapter contains the following sections:

- Before You Configure Your Network
- Configuring a Virtual Private Dialup Network
- Configuring IP Security
- Configuring the Dialer Interface
- Configuring the Ethernet Interfaces
- Configuring Dynamic Host Configuration Protocol
- Configuring Network Address Translation
- Configuring Firewalls
- Complete Sample Configuration

Before You Configure Your Network

Before you configure your network, you must do the following:

- Arrange for a digital subscriber line (DSL) or cable connection with your corporate network or service provider.
- If you are setting up an Internet connection, gather the following information:
  - Client name that is assigned as your login name
  - Authentication type
  - Password for accessing your Internet service provider (ISP) account
  - Domain Name System (DNS) server IP address and default gateways
- If you are setting up a connection to a corporate network, you and its network administrator must generate and share the following information for the interfaces of the routers connected to xDSL or cable modems:
  - Authentication type
  - Client name for accessing the router
  - Password for accessing the router
- If you are setting up Internet Protocol (IP) routing, generate the addressing scheme for your IP network.

Configuring a Virtual Private Dialup Network

Complete the following tasks to configure a virtual private dialup network (VPDN). Start in global configuration mode.

	Command	Task
Step 1	**vpdn enable**	Enable VPDN.
Step 2	**no vpdn logging**	Disable VPDN logging.
Step 3	**vpdn-group** *tag*	Configure a VPDN group.
Step 4	**request-dialin**	Specify the dialing direction.

	Command	Task
Step 5	**protocol pppoe**	Specify the tunneling protocol as PPPoE.
Step 6	**end**	Exit router configuration mode.

Configuring IP Security

IP Security (IPSec) is a framework of open standards for ensuring secure private communications over IP networks. Based on standards developed by the Internet Engineering Task Force (IETF), IPSec ensures confidentiality, integrity, and authenticity of data communications across a public IP network. Cisco's realization of IPSec implements the Data Encryption Standard (DES) and triple DES (3DES).

Refer to the *Cisco IOS Security Configuration Guide, Release 12.1*, for more detailed information on IPSec.

Perform the following tasks to configure IPSec. Start in global configuration mode.

	Command	Task
Step 1	**crypto isakmp policy 10**	Define an Internet Key Exchange (IKE) policy, and assign the policy a priority. This command places the router in IKE policy configuration mode.
Step 2	**hash** *algorithm*	Specify the hash algorithm for the policy.
Step 3	**encryption** *encryption*	Specify the encryption for the policy.
Step 4	**authentication pre-share**	Specify pre-share key as the authentication method.
Step 5	**exit**	Exit IKE policy configuration mode.
Step 6	**crypto isakmp key** *name* **address** *ip-address*	Configure a pre-share key and static IP address for each VPN client.
Step 7	**crypto ipsec transform-set** *name* **esp-***encryption* **esp-***hash algorithm***-hmac**	Define a combination of security associations to occur during IPSec negotiations.
Step 8	**crypto mib ipsec flowmib history tunnel size** *size*	Set the size of the tunnel history table.

	Command	Task
Step 9	**crypto mib ipsec flowmib history failure size** *size*	Set the size of the failure history table.
Step 10	**crypto map** *name* **local-address Ethernet 0**	Specify and name an identifying interface to be used by the crypto map for IPSec traffic
Step 11	**crypto map** *name seq-num* **ipsec-isakmp**	Create a crypto map entry in IPSec ISAKMP mode, and enter crypto map configuration mode.
Step 12	**set peer** *ip-address*	Identify the remote IPSec peer.
Step 13	**set transform-set** *name*	Specify the transform set to be used.
Step 14	**set pfs [group1|group2]**	Specify use of the perfect forward secrecy (pfs) option in IPSec. The variation **group1** is default.
Step 15	**match address** *access-list-id*	Specify an extended access list for the crypto map entry.
Step 16	**exit**	Exit crypto map configuration mode.

Disabling Hardware Encryption

The Cisco 1710 Security router is equipped with a Virtual Private Network (VPN) module that provides hardware 3DES encryption by default. It is possible to disable the VPN module and use Cisco IOS software encryption/decryption instead.

The command which disables the VPN module is as follows:

no crypto engine accelerator

The command is executed in configuration mode. An example of its use is as follows:

```
c1710(config)#no crypto engine accelerator
Warning! all current connections will be torn down.
Do you want to continue? [yes/no]: yes
.
Crypto accelerator in slot 0 disabled
.
switching to IPsec crypto engine
```

After this command is executed, it is necessary to perform the following procedures to bring up all encryption tunnels appropriately.

Step 1 On all involved routers, shut down the interfaces that have crypto maps applied to them.

Step 2 Enter the following commands on each of the involved routers.

Command	Task
clear crypto sa	Clears the security associations applied to the router.
clear crypto isakmp	Clears the active IKE connections to the router.
show crypto engine connections active	Lists the active connections. In this scenario, it verifies that no connections are active. It may be necessary to repeat these commands until no connections are listed.

Step 3 Bring up the interfaces on all involved routers that were shut down in Step 1.

To re-enable the VPN module, use the following command:

crypto engine accelerator

An example of its use is as follows:

```
c1710(config)#crypto engine accelerator
Warning! all current connections will be torn down.
Do you want to continue? [yes|no]:yes
.
switching to crypto accelerator.
```

The following is a useful command that shows statistical information about the VPN module:

show crypto engine accelerator statistic

An example of its use is as follows:

```
c1710#show crypto engine accelerator statistic
C1700_EM:
  ds: 0x81784BA4 idb:0x81780560
```

```
Statistics for Virtual Private Network (VPN) Module:
   0 packets in         0 packets out
   0 paks/sec in        0 paks/sec out
   0 Kbits/sec in       0 Kbits/sec out
rx_no_endp: 0 rx_hi_discards: 0 fw_failure: 0
invalid_sa: 0 invalid_flow: 0 cgx_errors 0
fw_qs_filled: 0 fw_resource_lock:0 lotx_full_err: 0
null_ip_error: 0 pad_size_error: 0 out_bound_dh_acc: 0
esp_auth_fail: 0 ah_auth_failure: 0 crypto_pad_error: 0
ah_prot_absent: 0 ah_seq_failure: 0 ah_spi_failure: 0
esp_prot_absent:0 esp_seq_fail: 0 esp_spi_failure: 0
obound_sa_acc: 0 invalid_sa: 0 out_bound_sa_flow: 0
invalid_dh: 0 bad_keygroup: 0 out_of_memory: 0
no_sh_secret: 0 no_skeys: 0 invalid_cmd: 0
dsp_coproc_err: 0 comp_unsupported:0 pak_too_big: 0
pak_mp_length_spec_fault: 0
tx_lo_queue_size_max 0 cmd_unimplemented: 0
159405 seconds since last clear of counters
Interrupts: Notify = 0, Reflected = 0, Spurious = 0
cgx_cmd_pending:0 packet_loop_max: 0 packet_loop_limit: 512
```

This command can also be used as follows to verify that the VPN module is disabled:

```
c1710#show crypto engine accelerator statistic
There is no crypto accelerator.
```

Configuring the Dialer Interface

Complete the following tasks to configure the dialer interface. Start in global configuration mode.

	Command	Task
Step 1	**interface dialer 0**	Enter Dialer 0 interface configuration.
Step 2	**ip address** *ip-address subnet-mask*	Set the IP address and subnet mask for the Dialer 0 interface.
Step 3	**ip mtu 1492**	Set the size of the IP maximum transmission unit (MTU).
Step 4	**encapsulation ppp**	Set the encapsulation type to PPP.
Step 5	**dialer pool 1**	Specify the dialer pool to be used.

	Command	Task
Step 6	**dialer-group 1**	Assign this interface to a dialer list.
Step 7	**ppp authentication chap**	Optional. Set the PPP authentication method to Challenge Handshake Authentication Protocol (CHAP).
Step 8	**exit**	Exit Dialer 0 interface configuration.

Configuring the Ethernet Interfaces

Configure the Ethernet interfaces by performing the following tasks. Begin in the global configuration mode.

	Command	Task
Step 1	**interface Ethernet 0**	Configure the Ethernet interface.
Step 2	**ip address** *ip-address subnet-mask*	Set the IP address and subnet mask for the Ethernet 0 interface.
Step 3	**ip nat outside**	Optional. Establish the Ethernet interface as the outside interface.
Step 4	**exit**	Exit Ethernet 0 interface configuration.
Step 5	**crypto map** *name*	Apply crypto map to the Ethernet interface.
Step 6	**interface FastEthernet 0**	Configure the Fast Ethernet interface.
Step 7	**ip address** *ip-address subnet-mask*	Set the IP address and subnet mask for the Fast Ethernet interface.
Step 8	**ip nat inside**	Optional. Establish the Fast Ethernet interface as the inside interface.
Step 9	**pppoe enable**	Optional. Enable PPPoE as protocol.
Step 10	**pppoe-client dial-pool-number 1**	Optional. Create the PPPoE dial pool.
Step 11	**exit**	Exit Fast Ethernet 0 interface configuration.

Configuring Dynamic Host Configuration Protocol

The Dynamic Host Configuration Protocol (DHCP) is used to enable hosts (DHCP clients) on an IP network to obtain their configurations from a server (DHCP server). This reduces the work necessary to administer an IP network. The most significant configuration option the client receives from the server is its IP address.

Perform the following tasks to configure DHCP. Begin in global configuration mode.

	Command	Task
Step 1	**ip dhcp excluded-address** *low-ip-address high-ip-address*	Prevent DHCP from assigning one or more IP addresses to potential clients.
Step 2	**ip dhcp pool** *name*	Enter DHCP configuration mode, and create a pool of IP addresses that can be assigned to DHCP clients.
Step 3	**network** *address subnet-mask*	Specify a range of IP addresses that can be assigned to the DHCP clients.
Step 4	**default-router** *ip-address*	Specify the default router.
Step 5	**domain-name** *domain name*	Specify the domain name.
Step 6	**dns-server** *ip-address*	Specify the DNS server.
Step 7	**netbios-name-server** *ip-address*	Specify the NetBIOS name server.
Step 8	**netbios-node-type** *node-type*	Specify the NetBIOS node type.
Step 9	**lease** *days* **lease infinite**	Specify the duration of the lease.

Configuration Example

In the following example, three DHCP address pools are created: one in network 172.16.0.0, one in subnetwork 172.16.1.0, and one in subnetwork 172.16.2.0. Attributes from network 172.16.0.0, such as the domain name, DNS server, NetBIOS name server, and NetBIOS node type, are inherited in subnetworks

172.16.1.0 and 172.16.2.0. In each pool, clients are granted 30-day leases and all addresses in each subnetwork, except the excluded addresses, are available to the DHCP server for assigning to clients.

```
ip dhcp database ftp://user:password@172.16.4.253/router-dhcp
write-delay 120
ip dhcp excluded-address 172.16.1.100 172.16.1.103
ip dhcp excluded-address 172.16.2.100 172.16.2.103
!
ip dhcp pool 0
 network 172.16.0.0 /16
 domain-name cisco.com
 dns-server 172.16.1.102 172.16.2.102
 netbios-name-server 172.16.1.103 172.16.2.103
 netbios-node-type h-node
!
ip dhcp pool 1
 network 172.16.1.0 /24
 default-router 172.16.1.100 172.16.1.101
 lease 30
!
ip dhcp pool 2
 network 172.16.2.0 /24
 default-router 172.16.2.100 172.16.2.101
 lease 30
```

Manual Binding Configuration Example

The following example creates a manual binding for a client named Mars.cisco.com. The MAC address of the client is 02c7.f800.0422 and the IP address of the client is 172.16.2.254.

```
ip dhcp pool Mars
 host 172.16.2.254
 hardware-address 02c7.f800.0422 ieee802
 client-name Mars
```

Because attributes are inherited, the previous configuration is equivalent to the following:

```
ip dhcp pool Mars
 host 172.16.2.254 mask 255.255.255.0
 hardware-address 02c7.f800.0422 ieee802
 client-name Mars
 default-router 172.16.2.100 172.16.2.101
 domain-name cisco.com
```

```
dns-server 172.16.1.102 172.16.2.102
netbios-name-server 172.16.1.103 172.16.2.103
netbios-node-type h-node
```

Configuring Network Address Translation

Network Address Translation (NAT) translates IP addresses within private "internal" networks to "legal" IP addresses for transport over public "external" networks (such as the Internet). Incoming traffic is translated back for delivery within the inside network. Thus, NAT allows an organization with unregistered "private" addresses to connect to the Internet by translating those addresses into globally registered IP addresses.

Ethernet interfaces are configured as "NAT inside" or "NAT outside" as shown in the previous section "Configuring the Ethernet Interfaces." Once the interfaces are configured, the following steps can be performed to establish the NAT configuration within the router.

	Command	Task
Step 1	**ip nat pool** *name start-ip end-ip* {**netmask** *netmask* | **prefix-length** *prefix-length*}	Create a pool of global IP addresses for NAT.
Step 2	**access-list** *access-list-number* **permit** *source* [*source-wildcard*]	Define a standard access list permitting addresses that need translation.
Step 3	**ip nat inside source list** *access-list-number* **pool** *name* **[overload]**	Enable dynamic translation of addresses permitted by access list. **Overload** allows the use of one global address, from the pool, for many local addresses.
Step 4	**ip nat outside source static** *global-ip local-ip*	Enable static translation of a specified outside source address. This command is optional.

Configuration Example

In this example, we want NAT to allow certain devices on the inside to originate communication with devices on the outside by translating their internal addresses to valid outside addresses or a pool of addresses. The pool in this example is defined as the range of addresses 172.16.10.1 through 172.16.10.63.

In order to accomplish this translation, we need to use dynamic NAT. With dynamic NAT, the translation table in the router is initially empty and gets populated once traffic that needs to be translated passes through the router. (This is opposed to static NAT, in which a translation is statically configured and is placed in the translation table without the need for any traffic.)

In this example, we can configure NAT to translate each inside device address to a unique valid outside address, or to translate each inside device address to the same valid outside address. The second method is known as *overloading*. An example of how to configure each method is given here.

To begin, configure the Fast Ethernet interface with an IP address and as a "NAT inside" interface.

```
interface FastEthernet 0
  ip address 10.10.10.1 255.255.255.0
  ip nat inside
```

Then configure the Ethernet interface with an IP address and as a "NAT outside" interface.

```
interface Ethernet 0
  ip address 172.16.10.64 255.255.255.0
  ip nat outside
```

To handle the case in which each inside address is translated to its own unique outside address, define a NAT pool named "no-overload" with a range of addresses from 172.16.10.0 to 172.16.10.63

```
ip nat pool no-overload 172.16.10.0 172.16.10.63 prefix 24
```

Define access list 7 to permit packets with source addresses ranging from 10.10.10.0 through 10.10.10.31 and from 10.10.20.0 through 10.10.20.31.

```
access-list 7 permit 10.10.10.0 0.0.0.31
access-list 7 permit 10.10.20.0 0.0.0.31
```

Then indicate that any packet received on the inside interface, as permitted by access list 7, will have its source address translated to an address from the NAT pool “no-overload.”

```
ip nat inside source list 7 pool no-overload
```

Alternatively, to handle the case where all inside addresses are translated to a single outside address, define a NAT pool named “ovrld,” which has a range of a single IP address: 172.16.10.1.

```
ip nat pool ovrld 172.16.10.1 172.16.10.1 prefix 24
```

Then indicate that any packet received on the inside interface, as permitted by access list 7, will have its source address translated to the address from the NAT pool “ovrld.” Translations will be overloaded, which will allow multiple inside devices to be translated to the same outside IP address.

```
ip nat inside source list 7 pool ovrld overload
```

The keyword **overload** used in this command allows NAT to translate multiple inside devices to the single address in the pool.

Another variation of this command is
ip nat inside source list *7* **interface Ethernet 0 overload**, which configures NAT to overload on the address that is assigned to the Ethernet 0 interface.

Configuring Firewalls

Basic traffic filtering is limited to configured access list implementations that examine packets at the network layer, or at most, the transport layer, permitting or denying the passage of each packet through the firewall. However, the use of inspection rules in Context-based Access Control (CBAC) allows creation and use of dynamic temporary access lists. These dynamic lists allow temporary openings in the configured access lists at firewall interfaces. These openings are created when traffic for a specified user session exits the internal network through the firewall. The openings allow returning traffic for the specified session (that would normally be blocked) back through the firewall.

Refer to the *Cisco IOS Security Configuration Guide, Release 12.1*, for more detailed information on traffic filtering and firewalls.

Access Lists

Access lists are configured as standard or extended. A standard access list either permits or denies passage of packets from a designated source. An extended access list allows designation of both the destination and the source, and it allows designation of individual protocols to be permitted or denied passage. An access list is a series of commands with a common tag to bind them together. The tag is either a number or a name.

Standard numbered access list commands take the following form:

access-list {1-99} {permit|deny} *source-addr [source-mask]*

Extended numbered access list commands take the following form:

access-list {100-199} {permit|deny} *protocol source-addr [source-mask] destination-addr [destination-mask]*

Named access list commands take the form:

ip access-list {standard|extended} *name*

A standard named access list command must be followed by subcommands in this form:

deny *{source|source-wildcard|***any***}*

An extended named access list command must be followed by a subcommand in this form:

{permit|deny} *protocol {source-addr[source-mask]|***any***} {destination-addr [destination-mask]|***any***}*

A sequence of access list commands bound together with a common name or number is referred to as an *access group*. An access group is enabled for an interface during interface configuration with the command

ip access-group *number|name* **[in|out]**

where **in|out** refers to the direction of travel of the packets being filtered.

When a sequence of access list commands is used, three things must be kept in mind:

- The order of commands in the sequence is important. A packet will be operated on by the first command. If there is no match (neither a permit nor a deny occurs), the next command operates on the packet, and so on.

- All matching parameters must be true before a command permits or denies access to a packet.
- There is an implicit “deny all” at the end of the sequence.

Configuration Examples

The following examples illustrate the configuration of standard numbered access lists and extended numbered access lists.

Configuring Standard Numbered Access Lists

In the following example, access list 2, a standard numbered access list, is defined to operate on the router, permitting or denying passage of packets associated with network 36.0.0.0. This network is a Class A network whose second octet specifies a subnet; that is, its subnet mask is 255.255.0.0. The third and fourth octets of a network 36.0.0.0 address specify a particular host. Using access list 2, the router would accept one address on subnet 48 and reject all others on that subnet. The last line of the list shows that the router would accept addresses on all other network 36.0.0.0 subnets.

```
access-list 2 permit 36.48.0.3
access-list 2 deny 36.48.0.0  0.0.255.255
access-list 2 permit 36.0.0.0  0.255.255.255
```

Note that all other accesses are implicitly denied.

The following commands tie the access group to a specific interface on the router, and specify that incoming packets are to be permitted or denied passage:

```
interface ethernet 0
  ip access-group 2 in
```

Configuring Extended Numbered Access Lists

In the following example, access list 102, an extended numbered access list, is defined. The first command permits any incoming TCP messages with destination ports greater than 1023. The second command permits incoming TCP messages to the SMTP port of host 128.88.1.2. The third command permits incoming ICMP messages for error feedback.

```
access-list 102 permit tcp 0.0.0.0 255.255.255.255 128.88.0.0 0.0.255.255 gt 1023
access-list 102 permit tcp 0.0.0.0 255.255.255.255 128.88.1.2 0.0.0.0 eq 25
access-list 102 permit icmp 0.0.0.0 255.255.255.255 128.88.0.0 255.255.255.255
```

The following commands tie the access group to a specific interface on the router and specify that incoming packets are to be permitted or denied passage:

```
interface ethernet 0
  ip access-group 102 in
```

Inspection Rules

Specify which protocols to examine by using the **ip inspect name** command. When inspection detects that the specified protocol is passing through the firewall, a dynamic access list is created to allow the passage of return traffic. The **timeout** parameter specifies the length of time the dynamic access list will remain active without return traffic passing through the router. When a timeout is reached, the dynamic access list is removed, and subsequent packets (possibly even valid ones) are not permitted.

For each protocol you want to inspect, enter a line in global configuration mode using the following syntax:

ip inspect name *inspection-name protocol* **timeout** *seconds*

Use the same *inspection-name* in multiple statements to group them into one set of rules. This set of rules can be activated elsewhere in the configuration by using the **ip inspect** *inspection-name* **in|out** command when configuring an interface at the firewall.

Complete Sample Configuration

An example configuration is presented here, in which a Cisco 1710 Security router is a PPPoE client connected through a modem to an external network access router. The router might be located in a branch office with the network access router located at the corporate site. One alternate scenario could be that the router is in a small or medium business, and the network access router belongs to a service provider. In each case, the network access router provides a dial-in data service with secure tunnels to the business or branch office for mobile users.

This example presents a full configuration of the Cisco 1710 Security router, along with a complementary configuration of IPSec on the network access router.

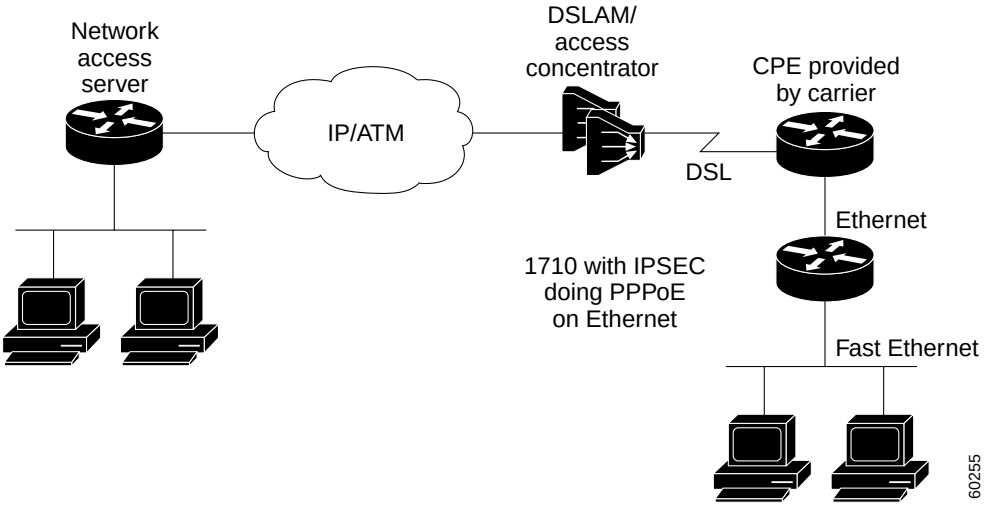
In this example, both the Cisco 1710 Security router and the network access router have inside and outside interfaces. The outside interfaces have global IP addresses while the inside interfaces have local IP addresses. These addresses are as follows:

- Cisco 1710 Security router outside interface: 24.119.216.150 255.255.255.0
- Cisco 1710 Security router inside interface: 192.168.1.0 255.255.255.0
- Network access router outside interface: 16.0.0.2 255.0.0.0
- Network access router inside interface: 172.28.0.1 255.255.0.0

The outside interface of the router in this example is the Ethernet port, while the inside interface is the Fast Ethernet port.

Figure 2-1 illustrates the topology of this example.

Figure 2-1 Configuration Example



Cisco 1710 Security Router Configuration

The following commands configure the router so that it provides a secure connection to the network access router.

```
ip domain-name cisco.com
ip name-server 24.1.64.33
ip name-server 24.1.64.34
ip dhcp excluded-address 192.168.1.1 192.168.1.5
!
ip dhcp pool home-pool
network 192.168.1.0 255.255.255.0
default-router 192.168.1.1
domain-name cisco.com
dns-server 24.1.64.34
!
ip inspect name fw_all ftp
ip inspect name fw_all http java-list 10
ip inspect name fw_all rcmd
ip inspect name fw_all rpc program-number 100000
ip inspect name fw_all smtp
ip inspect name fw_all tftp
ip inspect name fw_all realaudio
ip inspect name fw_all streamworks
ip inspect name fw_all vdolive
ip inspect name fw_all cuseeme
ip inspect name fw_all h323
ip inspect name fw_all tcp
ip inspect name fw_all udp
ip audit notify log
ip audit po max-events 100
!
vpdn enable
no vpdn logging
!
vpdn-group 1
request-dialin
protocol pppoe
!
crypto isakmp key 12abcjhrweit345 address 16.0.0.2
!
crypto isakmp policy 1
authentication pre-share
encryption 3des
hash sha
group 2
!
crypto ipsec transform-set proposal1 esp-3des esp-sha-hmac ah-sha-hmac
```

```
!
crypto map tag local-address Ethernet0
crypto map tag 10 ipsec-isakmp
set peer 16.0.0.2
set security-association level per-host
set transform-set proposal1
set pfs group2
match address 100
!
interface Dialer0
ip unnumbered Ethernet0
no ip route-cache
encapsulation ppp
ip mtu 1492
dialer pool 1
dialer-group 1
ip nat outside
ip inspect fw_all in
ip access-group 102 in
crypto map tag
!
interface FastEthernet0
ip address 192.168.1.1 255.255.255.0
ip nat inside
!
interface Ethernet0
ip address 24.19.216.150 255.255.255.0
pppoe enable
pppoe-client dial-pool-number 1
crypto map tag
!
dialer-list 1 protocol ip permit
!
access-list 100 permit 192.168.1.0 0.255.255.255
!
ip nat inside source list homenet interface Ethernet0 overload
ip nat outside source static 24.19.216.129 192.168.1.5
!
ip access-list extended homenet
 permit ip 192.168.1.0 0.255.255.255 any
!
access-list 102 deny   tcp any any
access-list 102 permit esp any any
access-list 102 permit ahp any any
access-list 102 permit udp any eq isakmp any eq isakmp
access-list 102 deny   udp any any
access-list 102 permit ip any any
access-list 102 permit icmp any any
```

Network Access Router Configuration

The following commands configure the network access router so that it provides a secure connection to the Cisco 1710 Security router.

```
crypto isakmp key 12abcjhrweit345 address 24.19.216.150
!
crypto isakmp policy 1
authentication pre-share
encryption 3des
hash sha
group 2
!
crypto ipsec transform-set proposal1 esp-3des esp-sha-hmac ah-sha-hmac
!
crypto map mymap1 local-address FastEthernet0/1
crypto map tag 10 ipsec-isakmp
set peer 24.19.216.150
set security-association level per-host
set transform-set proposal1
set pfs group2
match address 100
!
access-list 100 permit 172.28.0.0 0.0.255.255
!
interface FastEthernet0/1
ip address 16.0.0.2 255.0.0.0
crypto map tag
!
interface FastEthernet0/0
ip address 172.28.0.1 255.255.0.0
```

CHAPTER 3

Overview of Routing Between Virtual LANs

This chapter provides an overview of virtual LANs (VLANs). It describes the encapsulation protocols used for routing between VLANs and provides some basic information about designing VLANs.

This chapter contains the following sections:

- What Is a VLAN?
- VLAN Colors
- Why Implement VLANs?
- Communicating Between VLANs
- Designing Switched VLANs

What Is a VLAN?

A VLAN is a switched network that is logically segmented on an organizational basis, by function, project team, or application, rather than on a physical or geographical basis. For example, all workstations and servers used by a particular workgroup team can be connected to the same VLAN, regardless of their physical connections to the network or their intermingling with other teams. The network can be reconfigured by using software rather than by physically unplugging and moving the devices or wires.

A VLAN can be thought of as a broadcast domain that exists within a defined set of switches. A VLAN consists of a number of end systems, either hosts or network equipment (such as bridges and routers), connected by a single bridging domain. The bridging domain is supported on various pieces of network equipment; for example, LAN switches that operate bridging protocols between them with a separate bridge group for each VLAN.

VLANs are created to provide the segmentation services traditionally provided by routers in LAN configurations. VLANs address scalability, security, and network management. Routers in VLAN topologies provide broadcast filtering, security, address summarization, and traffic flow management. None of the switches within the defined group will bridge any frames, not even broadcast frames, between two VLANs. Several key issues need to be considered when designing and building switched LAN internetworks:

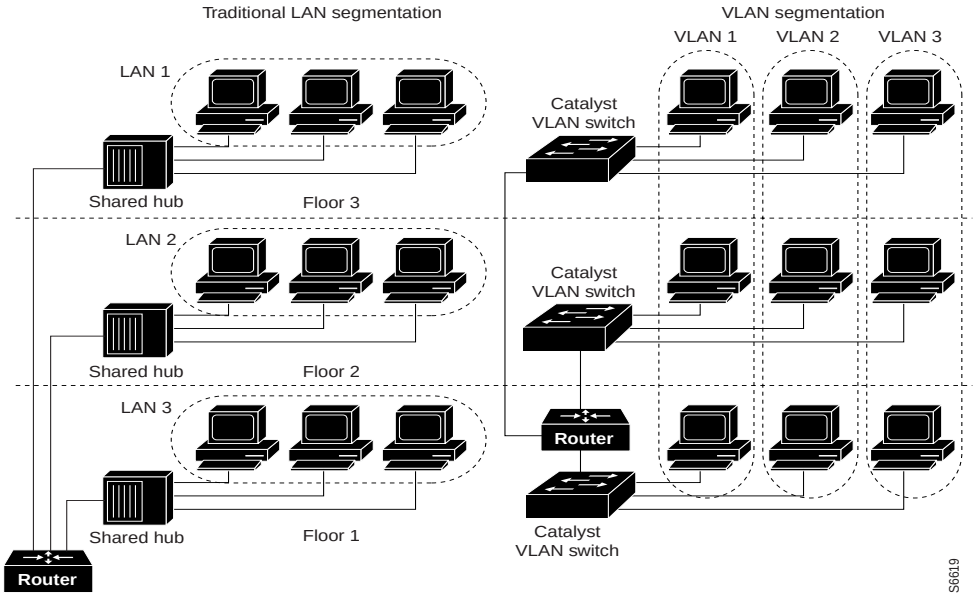
- LAN Segmentation
- Security
- Broadcast Control
- Performance
- Network Management
- Communication Between VLANs

LAN Segmentation

VLANs allow logical network topologies to be overlaid onto the physical switched infrastructure such that any arbitrary collection of LAN ports can be combined into an autonomous user group or community of interest. The technology logically segments the network into separate Layer 2 broadcast domains whereby packets are switched between ports designated to be within the same VLAN. By containing traffic originating on a particular LAN only to other LANs in the same VLAN, switched virtual networks avoid wasting bandwidth, a drawback inherent to traditional bridged and switched networks in which packets are often forwarded to LANs with no need for them. Implementation of VLANs also improves scalability, particularly in LAN environments that support broadcast- or multicast-intensive protocols and applications that flood packets throughout the network.

Figure 3-1 illustrates the difference between traditional physical LAN segmentation and logical VLAN segmentation.

Figure 3-1 LAN Segmentation and VLAN Segmentation



Security

VLANs also improve security by isolating groups. High-security users can be grouped into a VLAN, possibly on the same physical segment, and no users outside that VLAN can communicate with them.

Broadcast Control

Just as switches isolate collision domains for attached hosts and only forward appropriate traffic out a particular port, VLANs provide complete isolation between VLANs. A VLAN is a bridging domain; all broadcast and multicast traffic is contained within the VLAN.

Performance

The logical grouping of users allows an accounting group to make intensive use of a networked accounting system assigned to a VLAN that contains just that accounting group and its servers. That group's work will not affect other users. The VLAN configuration improves general network performance by not slowing down other users sharing the network.

Network Management

The logical grouping of users allows easier network management. It is not necessary to pull cables to move a user from one network to another. Adds, moves, and changes are achieved by configuring a port into the appropriate VLAN.

Communication Between VLANs

Communication between VLANs is accomplished through routing, and the traditional security and filtering functions of the router can be used. Cisco IOS software provides network services such as security filtering, quality of service (QoS), and accounting on a per VLAN basis. As switched networks evolve to distributed VLANs, Cisco IOS provides key inter-VLAN communications and allows the network to scale.

VLAN Colors

VLAN switching is accomplished through *frame tagging*, in which traffic originating and contained within a particular virtual topology carries a unique VLAN identifier (VLAN ID) as it traverses a common backbone or trunk link. The VLAN ID enables VLAN switching devices to make intelligent forwarding decisions based on the embedded VLAN ID. Each VLAN is differentiated by a *color*, or VLAN identifier. The unique VLAN ID determines the *frame coloring* for the VLAN. Packets originating and contained within a particular VLAN carry the identifier that uniquely defines that VLAN (by the VLAN ID).

The VLAN ID allows VLAN switches and routers to selectively forward packets to ports with the same VLAN ID. The switch that receives the frame from the source station inserts the VLAN ID, and the packet is switched onto the shared backbone network. When the frame exits the switched LAN, a switch strips the header and forwards the frame to interfaces that match the VLAN color. If you are using a Cisco network management product such as VlanDirector, you can actually color-code the VLANs and monitor VLAN graphically.

Why Implement VLANs?

Network managers can group logically networks that span all major topologies, including high-speed technologies such as, ATM, FDDI, and Fast Ethernet. By creating virtual LANs, system and network administrators can control traffic patterns and react quickly to relocations and keep up with constant changes in the network due to moving requirements and node relocation just by changing the VLAN member list in the router configuration. They can add, remove, or move devices or make other changes to network configuration using software to make the changes.

You should consider both the advantages and disadvantages of creating VLANs when you design your network, including these issues:

- Scalability
- Performance improvements
- Security
- Network additions, moves, and changes

Communicating Between VLANs

The Cisco 1710 Security router uses the IEEE 802.1Q protocol for routing between VLANs.

The IEEE 802.1Q protocol is used to interconnect multiple switches and routers and for defining VLAN topologies. IEEE 802.1Q support is currently available only for Fast Ethernet interfaces.

Procedures for configuring routing between VLANs with IEEE 802.1Q encapsulation are provided in the "Configuring Routing Between VLANs with IEEE 802.1Q Encapsulation" chapter later in this publication.

VLAN Translation

VLAN translation refers to the ability of the Cisco IOS software to translate between different virtual LANs or between VLAN and non-VLAN encapsulating interfaces at Layer 2. Translation is typically used for selective inter-VLAN switching of non-routable protocols and to extend a single VLAN topology across hybrid switching environments. It is also possible to bridge VLANs on the main interface; the VLAN encapsulating header is preserved. Topology changes in one VLAN domain do not affect a different VLAN.

Designing Switched VLANs

By the time you are ready to configure routing between VLANs, you will have already defined them through the switches in your network. Issues related to network design and VLAN definition should be addressed during your network design. Refer to the *Cisco Internetworking Design Guide* and appropriate switch documentation for information on these topics:

- Sharing resources between VLANs
- Load balancing
- Redundant links
- Addressing
- Segmenting networks with VLANs
- Routers and their role in switched networks

CHAPTER 4

Configuring Routing Between VLANs with IEEE 802.1Q Encapsulation

This chapter describes the required and optional tasks for configuring routing between VLANs with IEEE 802.1Q encapsulation. For complete descriptions of the VLAN commands used in this chapter, refer to the "Cisco IOS Switching Commands" chapter in the *Cisco IOS Switching Services Command Reference*. For documentation of other commands that appear in this chapter, you can either use the command reference master index or search online.

The IEEE 802.1Q protocol is used to interconnect multiple switches and routers and for defining VLAN topologies. IEEE 802.1Q support is currently available for Fast Ethernet interfaces.

Note The Cisco 1710 Security router supports IEEE 802.1Q only on the Fast Ethernet interface.

IEEE 802.1Q Encapsulation Configuration Task List

You can configure routing between any number of VLANs in your network. This section documents the configuration tasks for each protocol supported with IEEE 802.1Q encapsulation. The basic process is the same, regardless of the protocol being routed. It involves:

- Enabling the protocol on the router
- Enabling the protocol on the interface

- Defining the encapsulation format as IEEE 802.1Q
- Customizing the protocol according to the requirements for your environment

The configuration processes documented in this chapter include the following:

- Configuring AppleTalk Routing over IEEE 802.1Q
- Configuring IP Routing over IEEE 802.1Q
- Configuring IPX Routing over IEEE 802.1Q

Configuring AppleTalk Routing over IEEE 802.1Q

AppleTalk can be routed over virtual LAN (VLAN) subinterfaces, using the IEEE 802.1Q VLAN encapsulation protocol. AppleTalk Routing provides full-feature Cisco IOS software AppleTalk support on a per VLAN basis, allowing standard AppleTalk capabilities to be configured on VLANs.

To route AppleTalk over IEEE 802.1Q between VLANs, you need to customize the subinterface to create the environment in which it will be used. Perform these tasks in the order in which they appear:

- Enabling AppleTalk Routing
- Defining the VLAN Encapsulation Format
- Configuring AppleTalk on the Subinterface

Enabling AppleTalk Routing

To enable AppleTalk routing on IEEE 802.1Q interfaces, use the following command in global configuration mode:

Command	Purpose
appletalk routing [**eigrp** *router-number*]	Enables AppleTalk routing globally.

Note For more information on configuring AppleTalk, see the "Configuring AppleTalk" chapter in the *Cisco IOS AppleTalk and Novell IPX Configuration Guide*.

Configuring AppleTalk on the Subinterface

After you enable AppleTalk globally and define the encapsulation format, you need to enable it on the subinterface by specifying the cable range and naming the AppleTalk zone for each interface. To enable the AppleTalk protocol on the subinterface, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	**appletalk cable-range** *cable-range* [*network.node*]	Assigns the AppleTalk cable range and zone for the subinterface.
Step 2	**appletalk zone** *zone-name*	Assigns the AppleTalk zone for the subinterface.

Defining the VLAN Encapsulation Format

To define the VLAN encapsulation format as IEEE 802.1Q, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	**interface fastethernet** *port.subinterface-number*	Specifies the subinterface that the VLAN will use.
Step 2	**encapsulation dot1q** *vlan-identifier*	Defines the encapsulation format as IEEE 802.1Q (**dot1q**) and specifies the VLAN identifier.

Configuring IP Routing over IEEE 802.1Q

IP routing over IEEE 802.1Q extends IP routing capabilities to include support for routing IP frame types in VLAN configurations using the IEEE 802.1Q encapsulation.

To route IP over IEEE 802.1Q between VLANs, you need to customize the subinterface to create the environment in which it will be used. Perform these tasks in the order in which they appear:

- Enabling IP Routing
- Defining the VLAN Encapsulation Format
- Assigning an IP Address to a Network Interface

Enabling IP Routing

IP routing is automatically enabled in the Cisco IOS software for routers. To re-enable IP routing if it has been disabled, use the following command in global configuration mode:

Command	Purpose
`ip routing`	Enables IP routing on the router.

Once you have IP routing enabled on the router, you can customize the characteristics to suit your environment. If necessary, refer to the IP configuration chapters in the *Cisco IOS IP and IP Routing Configuration Guide* for guidelines on configuring IP.

Defining the VLAN Encapsulation Format

To define the encapsulation format as IEEE 802.1Q, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	`interface fastethernet` *`port.subinterface-number`*	Specifies the subinterface on which IEEE 802.1Q will be used.
Step 2	`encapsulation dot1q` *`vlanid`*	Defines the encapsulation format as IEEE 802.1Q (**dot1q**) and specifies the VLAN identifier.

Assigning an IP Address to a Network Interface

An interface can have one primary IP address. To assign a primary IP address and a network mask to a network interface, use the following command in interface configuration mode:

Command	Purpose
ip address *ip-address mask*	Sets a primary IP address for an interface.

A mask identifies the bits that denote the network number in an IP address. When you use the mask to subnet a network, the mask is then referred to as a *subnet mask*.

Configuring IPX Routing over IEEE 802.1Q

IPX Routing over IEEE 802.1Q VLANs extends Novell NetWare routing capabilities to include support for routing Novell Ethernet_802.3 encapsulation frame types in VLAN configurations. Users with Novell NetWare environments can configure Novell Ethernet_802.3 encapsulation frames to be routed using IEEE 802.1Q encapsulation across VLAN boundaries.

To configure Cisco IOS software on a router with connected VLANs to exchange IPX Novell Ethernet_802.3 encapsulated frames, perform these tasks in the order in which they are appear:

- Enabling NetWare Routing
- Defining the VLAN Encapsulation Format
- Configuring NetWare on the Subinterface

Enabling NetWare Routing

To enable IPX routing on IEEE 802.1Q interfaces, use the following command in global configuration mode:

Command	Purpose
ipx routing [*node*]	Enables IPX routing globally.

Defining the VLAN Encapsulation Format

To define the encapsulation format as IEEE 802.1Q, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	**interface fastethernet** *port.subinterface-number*	Specifies the subinterface on which IEEE 802.1Q will be used.
Step 2	**encapsulation dot1q** *vlan-identifier*	Defines the encapsulation format as IEEE 802.1Q and specifies the VLAN identifier.

Configuring NetWare on the Subinterface

After you enable NetWare globally and define the VLAN encapsulation format, you may need to enable the subinterface by specifying the NetWare network number. Use this command in interface configuration mode:

Command	Purpose
ipx network *network*	Specifies the IPX network number.

Examples of IEEE 802.1Q Encapsulation Configuration

This section provides configuration examples for each of the protocols described in this chapter. The section provides the examples for the following:

- Configuring AppleTalk over IEEE 802.1Q
- Configuring IP Routing over IEEE 802.1Q
- Configuring IPX Routing over IEEE 802.1Q

Configuring AppleTalk over IEEE 802.1Q

This configuration example shows AppleTalk being routed on VLAN 100:

```
!
appletalk routing
!
interface fastethernet 0.100
  encapsulation dot1q 100
  appletalk cable-range 100-100 100.1
  appletalk zone eng
!
```

Configuring IP Routing over IEEE 802.1Q

This configuration example shows IP being routed on VLAN 101:

```
!
ip routing
!
interface fastethernet 0.101
  encapsulation dot1q 101
  ip addr 10.0.0.11 255.0.0.0
!
```

Configuring IPX Routing over IEEE 802.1Q

This configuration example shows IPX being routed on VLAN 102:

```
!
ipx routing
!
interface fastethernet 0.102
  encapsulation dot1q 102
  ipx network 100
!
```

VLAN Commands

This section provides an alphabetical listing of all the VLAN commands that are new or specific to the Cisco 1710 router. All other commands used with this feature are documented in the Cisco IOS Release 12.1T command reference documents.

clear vlan statistics

To remove virtual LAN statistics from any statically or system configured entries, use the **clear vlan statistics** privileged EXEC command:

clear vlan statistics

Syntax Description

This command has no arguments or keywords.

Default

No default behavior or values.

Command Mode

Privileged EXEC.

Example

The following example clears VLAN statistics:

```
clear vlan statistics
```

debug vlan packets

Use the **debug vlan packets** privileged EXEC command to display general information on virtual LAN (VLAN) packets that the router received but is not configured to support:

debug vlan packets

The **no** form of this command disables debugging output:

no debug vlan packets

Syntax Description

This command has no arguments or keywords.

Command Mode

Privileged EXEC.

Usage Guidelines

The **debug vlan packets** command displays only packets with a VLAN identifier that the router is not configured to support. This command allows you to identify other VLAN traffic on the network. Virtual LAN packets that the router is configured to route or switch are counted and indicated when you use the **show vlans** command.

Example

The following is sample output from the **debug vlan packets** output:

```
Router# debug vlan packets

Virtual LAN packet information debugging is on
```

encapsulation dot1q

To enable IEEE 802.1Q encapsulation of traffic on a specified subinterface in virtual LANs, use the **encapsulation dot1q** command in subinterface configuration mode. IEEE 802.1Q is a standard protocol for interconnecting multiple switches and routers and for defining VLAN topologies.

The command is as follows:

encapsulation dot1q *vlan-id*

Syntax Description

vlan-id	Virtual LAN identifier. The allowed range is from 1 to 4095.

Default

Disabled.

Command Mode

Subinterface configuration.

Usage Guidelines

IEEE 802.1Q encapsulation is configurable on Fast Ethernet interfaces.

Example

The following example encapsulates VLAN traffic, using the IEEE 802.1Q protocol for VLAN 100:

```
interface fastethernet 0.100
  encapsulation dot1q 100
```

show vlans

To view virtual LAN (VLAN) subinterfaces, use the **show vlans** privileged EXEC command:

show vlans

Syntax Description

This command has no arguments or keywords.

Command Mode

Privileged EXEC.

Example

The following is sample output from the **show vlans** command:

```
1710_2# show vlans

Virtual LAN ID:1 (IEEE 802.1Q Encapsulation)

   vLAN Trunk Interface: FastEthernet0

This is configured as native Vlan for the following interface(s):
FastEthernet0

   Protocols Configured: Address: Received: Transmitted:

Virtual LAN ID:100 (IEEE 802.1Q Encapsulation)

   vLAN Trunk Interface: FastEthernet0.100

   Protocols Configured: Address: Received: Transmitted:
      IP                100.0.0.2     10       10

Virtual LAN ID:2500 (IEEE 802.1Q Encapsulation)

   vLAN Trunk Interface: FastEthernet0.200

   Protocols Configured: Address: Received: Transmitted:
      IP                200.0.0.2      5         5
```

Table 4-1 describes the fields shown in the output.

Table 4-1 show vlans Field Descriptions

Field	Description
Virtual LAN ID	Domain number of the VLAN
vLAN Trunk Interface	Subinterface that carries the VLAN traffic
Protocols Configured	Protocols configured on the VLAN
Address	Network address
Received	Packets received
Transmitted	Packets transmitted

ROM Monitor

This appendix describes the Cisco 1710 Security router ROM monitor (also called the bootstrap program). The ROM monitor firmware runs when the router is powered up or reset and helps to initialize the processor hardware and boot the operating system software. You can perform certain configuration tasks, such as recovering a lost password or downloading software over the console port, by using ROM monitor. If there is no Cisco IOS software image loaded on the router, the ROM monitor runs the router.

This appendix contains the following sections:

- Entering the ROM Monitor
- ROM Monitor Commands
- Command Descriptions
- Disaster Recovery with TFTP Download
- Configuration Register
- Console Download

Entering the ROM Monitor

To use the ROM monitor, you must be using a terminal or PC that is connected to the router over the console port. Refer to the installation chapter in the *Cisco 1710 Security Router Hardware Installation Guide* that came with the router to connect the router to a PC or terminal.

Follow these steps to configure the router to boot up in ROM monitor mode the next time it is rebooted:

Step	Task	Router Prompt	Command
1.	If there is an enable password configured, enter the enable command and the enable password to enter privileged EXEC mode.	1700>	**enable**
2.	Enter global configuration mode.	1700#	**configure terminal**
3.	Reset the configuration register.	1700(config)#	**config-reg 0x0**
4.	Exit global configuration mode.	1700(config)#	**exit**
5.	Reboot the router with the new configuration register value. The router remains in ROM monitor and does not boot the Cisco IOS software. As long as the configuration value is 0x0, you must manually boot the operating system from the console. Refer to the **boot** command in the "Command Descriptions" section later in this appendix.	1700#	**reload**
6.	After the router reboots, it is in ROM monitor mode. The number in the prompt increments with each new line.	rommon 1>	

Timesaver Break (system interrupt) is always enabled for 60 seconds after the router reboots, regardless of whether it is set to on or off in the configuration register. During this 60-second window, you can break to the ROM monitor prompt by pressing the Break key.

ROM Monitor Commands

Enter **?** or **help** at the ROM monitor prompt to display a list of available commands and options, as follows:

```
rommon 1 > ?
alias             set and display aliases command
boot              boot up an external process
break             set/show/clear the breakpoint
confreg           configuration register utility
cont              continue executing a downloaded image
context           display the context of a loaded image
cookie            display contents of cookie PROM in hex
dev               list the device table
dir               list files in file system
dis               display instruction stream
dnld              serial download a program module
frame             print out a selected stack frame
help              monitor builtin command help
history           monitor command history
meminfo           main memory information
repeat            repeat a monitor command
reset             system reset
set               display the monitor variables
stack             produce a stack trace
sync              write monitor environment to NVRAM
sysret            print out info from last system return
tftpdnld          tftp image download
unalias           unset an alias
unset             unset a monitor variable
xmodem            x/ymodem image download
```

Commands are case sensitive. You can halt any command by pressing the Break key on a terminal. If you are using a PC, most terminal emulation programs halt a command when you press the Ctrl and the Break keys at the same time. If you are using another type of terminal emulator or terminal emulation software, refer to the documentation for that product for information on how to send a Break command.

Command Descriptions

This section describes the most commonly used ROM monitor commands:

Table A-1 Most Commonly Used ROM Monitor Commands

Command	Description
help or **?**	Displays a summary of all available ROM monitor commands.

-?	Displays information about command syntax, for example:
	`rommon 16 > dis -?`
	`usage : dis [addr] [length]`
	
	The output for this command is slightly different for the **xmodem** download command:
	`rommon 11 > xmodem -?`
	`xmodem: illegal option -- ?`
	`usage: xmodem [-cyrx] <destination filename>`
	`-c CRC-16`
	`-y ymodem-batch protocol`
	`-r copy image to dram for launch`
	`-x do not launch on download completion`

reset or **i**	Resets and initializes the router, similar to a power up.

dev	Lists boot device identifications on the router. For example:
	`rommon 2> dev`
	`Devices in device table:`
	`id name`
	`flash: flash`
	`eprom: eprom`

dir *device***:**	Lists the files on the named device (Flash, for example):
	`rommon 1> dir flash:`
	`File size Checksum File name`
	`7729736 bytes (0x75f248) 0xb86d c1700-bk9no3r2sy7-mz.0412`

Boot Commands	For more information about the ROM monitor boot commands, see the *Cisco IOS Configuration Guide* and *Cisco IOS Command Reference* publications.
b	Boots the first image in Flash memory.

Table A-1 Most Commonly Used ROM Monitor Commands (continued)

Command	Description
b flash: [*filename*]	Attempts to boot the image directly from the first partition of Flash memory. If you do not enter a filename, this command will boot this first image in Flash.
b flash:2: [*filename*]	Attempts to boot the image directly from the second partition of Flash memory. f you do not enter a filename, this command will boot this first image in the second partition of Flash memory.

Disaster Recovery with TFTP Download

The standard way to load new software on your router is using the **copy tftp flash** privileged EXEC command from the Cisco IOS software command-line interface (CLI). However, if the router is unable to boot the Cisco IOS software, you can load new software while in ROM monitor mode.

This section describes how to, while in ROM monitor mode, load a Cisco IOS software image from a remote TFTP server to the router Flash memory. Use the **tftpdnld** command only for disaster recovery because it erases all existing data in Flash memory before downloading a new software image to the router.

Note The 10BASE-T Ethernet Port is not active in ROM monitor mode, and thus cannot be used for TFTP Download.

TFTP Download Command Variables

This section describes the system variables that can be set in ROM monitor mode and that are used during the TFTP download process. There are required and optional variables.

Note The commands described in this section are case-sensitive and must be entered exactly as shown in the lists.

Required Variables

The following variables must be set with the commands shown before using the **tftpdnld** command:

Variable	Command
IP address of the router.	**IP_ADDRESS=** *ip_address*
Subnet mask of the router.	**IP_SUBNET_MASK=** *ip_address*
IP address of the default gateway of the router.	**DEFAULT_GATEWAY=** *ip_address*
IP address of the TFTP server from which the software will be downloaded.	**TFTP_SERVER=** *ip_address*
The name of the file that will be downloaded to the router.	**TFTP_FILE=** *filename*

Optional Variables

The folowing variables can be set with the commands shown before using the **tftpdnld** command:

Variable	Command
Configures how the router displays file download progress. **0**—No progress is displayed. **1**—Exclamation points (!!!) are displayed to indicate file download progress. This is the default setting. **2**—Detailed progress is displayed during the file download process. For example: Initializing interface. Interface link state up. ARPing for 1.4.0.1 ARP reply for 1.4.0.1 received. MAC address 00:00:0c:07:ac:01	**TFTP_VERBOSE=** *setting*
Number of times the router attempts ARP and TFTP download. The default is 7.	**TFTP_RETRY_COUNT=** *retry_times*
Amount of time, in seconds, before the download process times out. The default is 2, 400 seconds (40 minutes).	**TFTP_TIMEOUT=** *time*
Whether or not the router performs a checksum test on the downloaded image: **1**—Checksum test is performed. **0**—No checksum test is performed.	**TFTP_CHECKSUM=***setting*

Using the TFTP Download Command

The steps described in this section should be performed while in ROM monitor mode.

Step 1 Use the appropriate commands to enter all the required variables and any optional variables described earlier in this section.

Step 2 Enter the **tftpdnld** command as follows:

```
rommon 1 > tftpdnld [ -r ]
```

Note The **-r** variable is optional. Entering this variable downloads and boots the new software but does not save the software to Flash. You can then use the image that is in Flash the next time you enter the **reload** command in the Cisco IOS software CLI.

You will see output similar to the following:

```
IP_ADDRESS: 10.0.0.1
      IP_SUBNET_MASK: 255.255.0.0
     DEFAULT_GATEWAY: 1.3.0.1
         TFTP_SERVER: 223.255.254.254
           TFTP_FILE: c1700-bnr2sy-mz.070298
Invoke this command for disaster recovery only.
WARNING: all existing data in all partitions on flash will be lost!
Do you wish to continue? y/n:  [n]:
```

Step 3 If you are sure that you want to continue, enter **y** in response to the question in the output:

```
Do you wish to continue? y/n:  [n]:y
```

The router will begin to download the new file.

Pressing Ctrl-C or Break stops the transfer before the Flash memory is erased.

Configuration Register

The virtual configuration register is in NVRAM and has the same functionality as other Cisco routers. You can view or modify the virtual configuration register from either the ROM monitor or the operating system software.

To change the virtual configuration register from the ROM monitor, enter **confreg** by itself for menu mode, or enter the new value of the register in hexadecimal.

confreg [*hexnum*]—Change the virtual configuration register to the value specified. The value is always interpreted as hexadecimal. Entering **confreg** without an argument displays the contents of the virtual configuration register and a prompt to alter the contents by describing the meaning of each bit.

In either case, the new virtual configuration register value is written into NVRAM, but does not take effect until you reset or power-cycle the router.

The following display shows an example of menu mode:

```
rommon 7> confreg

     Configuration Summary
enabled are:
console baud: 9600
boot: the ROM Monitor

do you wish to change the configuration? y/n  [n]:  y
enable  "diagnostic mode"? y/n  [n]:  y
enable  "use net in IP bcast address"? y/n  [n]:
enable  "load rom after netboot fails"? y/n  [n]:
enable  "use all zero broadcast"? y/n  [n]:
enable  "break/abort has effect"? y/n  [n]:
enable  "ignore system config info"? y/n  [n]:
change console baud rate? y/n  [n]:  y
enter rate: 0 = 9600, 1 = 4800, 2 = 1200, 3 = 2400
 4 = 19200, 5 = 38400, 6 = 57600, 7 = 115200   [0]:  0
change the boot characteristics? y/n  [n]:  y
enter to boot:
 0 = ROM Monitor
 1 = the boot helper image
 2-15 = boot system
    [0]:  0

Configuration Summary
enabled are:
diagnostic mode
console baud: 9600
```

```
boot: the ROM Monitor

do you wish to change the configuration? y/n  [n]:


You must reset or power cycle for new config to take effect
```

Console Download

You can use console download, a ROM monitor function, to download over the router console port either a software image or a configuration file. After download, the file is either saved to the mini-Flash module or to main memory for execution (image files only).

Use console download when you do not have access to a TFTP server.

Note If you want to download a software image or a configuration file to the router over the console port, you must use the ROM monitor command.

Note If you are using a PC to download a Cisco IOS image over the router console port at 115,200 bps, ensure that the PC serial port is using a 16550 universal asynchronous receiver/transmitter (UART). If the PC serial port is not using a 16550 UART, we recommend using a speed of 38,400 or lower when downloading a Cisco IOS image over the console port.

Command Description

Following are the syntax and argument descriptions for the **xmodem** console download command.

The syntax is as follows:

xmodem [**-cyrx**] *destination_file_name*

The argument descriptions are as follows:

Argument	Description
c	Optional. Performs the download using CRC-16 error checking to validate packets. Default is 8-bit CRC.
y	Optional. Sets the router to perform the download using ymodem protocol. Default is xmodem protocol. The protocols differ as follows: • xmodem supports a 128-block transfer size. ymodem supports a 1024-block transfer size. • ymodem uses 16-bit cyclic redundancy check (CRC)-16 error checking to validate each packet. Depending on the device that the software is being downloaded from, this function might not be supported by xmodem.
r	Optional. Image is loaded into DRAM for execution. Default is to load the image into Flash memory.
x	Optional. Image is loaded into DRAM without being executed.
destination_file_name	The name of the system image file or the system configuration file. In order for the router to recognize it, the name of the configuration file must be *router_confg*.

Error Reporting

Because the ROM monitor console download uses the console to perform the data transfer, error messages are displayed on the console only when the data transfer is terminated.

If an error does occur during a data transfer, the transfer is terminated, and an error message is displayed. If you have changed the baud rate from the default rate, the error message is followed by a message telling you to restore the terminal to the baud rate specified in the configuration register.

Debug Commands

Most ROM monitor debugging commands are functional only when Cisco IOS software has crashed or is halted. If you enter a debugging command and Cisco IOS crash information is not available, you see the following error message:

```
"xxx: kernel context state is invalid, can not proceed."
```

The following are ROM monitor debugging commands:

- **stack** or **k**—Produce a stack trace. For example:

```
rommon 6> stack
Stack trace:
PC = 0x801111b0
Frame 00: FP = 0x80005ea8    PC = 0x801111b0
Frame 01: FP = 0x80005eb4    PC = 0x80113694
Frame 02: FP = 0x80005f74    PC = 0x8010eb44
Frame 03: FP = 0x80005f9c    PC = 0x80008118
Frame 04: FP = 0x80005fac    PC = 0x80008064
Frame 05: FP = 0x80005fc4    PC = 0xfff03d70
```

- **context**—Display processor context. For example:

```
rommon 7> context
CPU context of the most recent exception:
PC  = 0x801111b0  MSR = 0x00009032  CR  = 0x53000035  LR    =
0x80113694
CTR = 0x801065e4  XER = 0xa0006d36  DAR = 0xffffffff  DSISR =
0xffffffff
DEC = 0xffffffff  TBU = 0xffffffff  TBL = 0xffffffff  IMMR  =
0xffffffff
R0  = 0x00000000  R1  = 0x80005ea8  R2  = 0xffffffff  R3    =
0x00000000
```

```
R4  = 0x8fab0d76  R5  = 0x80657d00  R6  = 0x80570000  R7    =
0x80570000
R8  = 0x00000000  R9  = 0x80570000  R10 = 0x0000954c  R11   =
0x00000000
R12 = 0x00000080  R13 = 0xffffffff  R14 = 0xffffffff  R15   =
0xffffffff
R16 = 0xffffffff  R17 = 0xffffffff  R18 = 0xffffffff  R19   =
0xffffffff
R20 = 0xffffffff  R21 = 0xffffffff  R22 = 0xffffffff  R23   =
0xffffffff
R24 = 0xffffffff  R25 = 0xffffffff  R26 = 0xffffffff  R27   =
0xffffffff
R28 = 0xffffffff  R29 = 0xffffffff  R30 = 0xffffffff  R31   =
0xffffffff
```

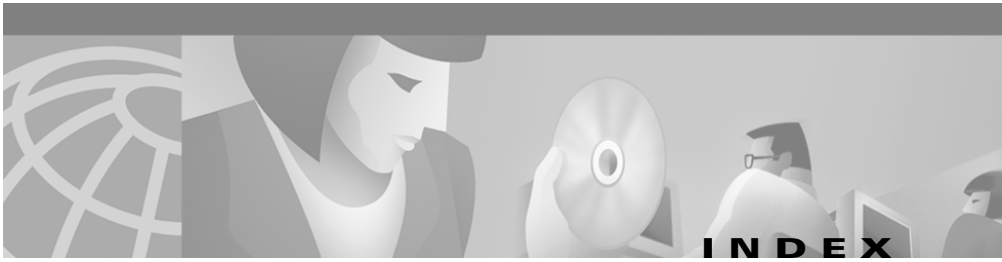
- **frame**—Display an individual stack frame.
- **sysret**—Display return information from the last booted system image. This information includes the reason for terminating the image, a stack dump of up to eight frames, and, if an exception is involved, the address where the exception occurred. For example:

```
rommon 8> sysret
System Return Info:
count: 19,  reason: user break
pc:0x801111b0,  error address: 0x801111b0
Stack Trace:
FP: 0x80005ea8, PC: 0x801111b0
FP: 0x80005eb4, PC: 0x80113694
FP: 0x80005f74, PC: 0x8010eb44
FP: 0x80005f9c, PC: 0x80008118
FP: 0x80005fac, PC: 0x80008064
FP: 0x80005fc4, PC: 0xfff03d70
FP: 0x80005ffc, PC: 0x00000000
FP: 0x00000000, PC: 0x00000000
```

- **meminfo**—Display size in bytes, starting address, available range of main memory, the starting point and size of packet memory, and size of nonvolatile random-access memory (NVRAM). For example:

```
rommon 3> meminfo

Main memory size: 64 MB.
Available main memory starts at 0x10000, size 65472KB
IO (packet) memory size: 25 percent of main memory.
NVRAM size: 32KB
```



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